ON SOME SOUND VALUES IN ENGLISH

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NOTE. We make a minimum use of phonetic symbols: [ɑ] as in *far*; [i] is the vowel of *seen*, [si:n]; [ɪ] the vowel of *bit*, [bɪt]; [u] the vowel of *pool* [pu:l]; the *i* of *tide* is [ai]; a colon [:] indicates length in the preceding vowel. For convenience sake we call the vowel of *that* [æ], a back vowel, to distinguish it from the much more 'fronted' [i] and [ɪ].

I. SOUND SYMBOLISM

It is no exaggeration to say that all the problems of language, even those relating to such apparently mechanical and unconscious phenomena as changes in pronunciation, which may embrace whole regions and take over a century to unfold themselves, are ultimately, to a greater or less degree, problems of psychology. This is supremely true of the greatest and most fundamental problem of all, the symbolization of ideas by sound. Whatever we may think of the theories that have been put forward to explain the origin of speech, and they are many and varied, it seems reasonable to suppose that in the early stages of language development the physical components of speech, i.e. the sounds themselves, with their variations of quality, tone, and stress, must have had some concrete intrinsic value before becoming mere tokens for the ready exchange of ideas. Just as our money developed from the metal weight to the bank-note or the cheque, just as our writing developed from the pictorial hieroglyphic to the phonetic symbol, so it may be conjectured that language itself progressed from the representational (not necessarily imitative) to the symbolic, and that the first sound groups, whether originally naming-words or, as is far more probable, words with sentence value (as in the speech of young children), were stimuli and accompaniments of action rather than of thought, and demonstrative signals rather than purely conventional signs.

This conjectural probability would receive notable confirmation if we could discover in the fully developed languages of to-day evidence of this primary representational character of speech, and point with assurance to specific cases where sense and sound generically correspond. This problem of sound-symbolism, as it is called, has not been entirely neglected; but the scrupulous philologist, fearing to be thought unscientific, tends to adopt with regard to it an attitude of suspicion, if not actually of disdain. He will agree that there are numbers of onomatopoeic words, words which imitate more or less convincingly the sounds characteristic of certain objects (animate or inanimate) and actions, but he is reluctant to go further and admit, in the less immediately imitative components of speech, any direct and inherent relationship between sound and sense, between the physical phenomena of utterance and the 'meaning' for which that utterance is a vehicle. When confronted with the fact that poetry, by rime and alliteration, and the

choice and order of words, purposely avails itself of sound and sense correspondences, or endeavours to create them—

> 'Tis not enough no harshness gives offence;
> The sound must seem an echo to the sense.
> Soft is the strain when Zephyr gently blows,
> And the smooth stream in smoother numbers flows;
> But when loud surges lash the sounding shore,
> The hoarse rough verse should like the torrent roar.
>
> Pope, *Essay on Criticism*

—he will aver that the poet merely avails himself of accidental discords and harmonies, that whatever representational or expressive value the sounds may have is, when not entirely subjective, solely due to their associative environment, and that it is the words and their setting which awaken the expressive possibilities latent in the sounds, and not the sounds which confer expressiveness to the words.

II. Expressive sound and language change

That there is truth in this contention no one would deny. But it is not the whole truth. In the first place, there are sounds, cries for example, which, so to speak, create their own contexts and carry their own meaning without being verbalized, though, admittedly, these are scarcely language. Secondly, and here we are definitely on the linguistic level, there are words which resist a prevailing tendency to sound change (a 'sound-law') because such a change would impair their adequacy as phonetic vehicles for the idea they convey. Latin *cacare*, for example, has become *chier* in French by a process of perfectly regular sound change (cp. *pacare* = *payer*, and *capu(t)* = Old. Fr. *chief*, Mod. Fr. *chef*) but the nursery noun *caca* has not changed since Roman times. This case may be felt to be one of onomatopoeia, and it is well known that, for obvious reasons, onomatopoeic, imitative words are refractory to the 'laws' of sound change; for example, whatever may happen in English to the sound [u] (cp. Old Eng. *hus* and Mod. *house*) the name of the *cuckoo* will suffer little or no change, while *cuckold*, with which it is apparently etymologically associated (Fr. *cocu*, 'cuckold', originally meant 'cuckoo'), will follow unresistingly the general phonetic trend. But what of the Spanish expletive *hoder!*, which goes back to the Latin *futuere*? In all other cases where Lat. initial [f] has changed to [h] in Castilian (e.g. *filia* = *hija*, *folia* = *hoja*, etc.) the [h] has long since ceased to be pronounced. In *hoder!* it is still strongly aspirated. It is fair to suppose that this breach of a phonetic 'law' is due to the expressive value of the aspirate as a functional component of this expletive word. Thirdly, there are words whose semantic development seems, to some extent at least, to have been determined by their phonetic make-up. The French adjective *sec* is a case in point. If in an expression like 'un coup sec', i.e. 'a sharp knock' or 'a jerk', it has acquired a meaning which is entirely alien to that of Eng. *dry*, its normal equivalent, is it not clear that this development is due in a great measure to the expressive value of its final consonant [k] (cp. *knock*, *click*, *smack*, *crack*, etc. in English, and Fr. *claque*, *claquer*, *plaquer*, *choc*, etc.)? Finally, although the vast majority of our words are now quite colourless from the sound-symbolism point of view, it is undeniable that both to the literary artist and the naïve user of speech there are a great many words which, without being deliberately imitative, although, possibly, many of them, onomatopoeic in origin, do seem to unite sound and sense in a specially appropriate combination: *ripple*, *flurry*,

crunch, slug, twinkle, are a few among the many one might quote. This phenomenon, which is particularly noticeable in English, and which distinguishes our vocabulary from the far more abstract or intellectualized vocabulary of French, is clearly a matter worthy of careful examination. Such questions may leave the 'historical' etymologist or the 'historical' grammarian cold; but the linguist, who approaches his material from the present-day functional angle, and the psychologist, who is concerned with the attitude of speakers to the sounds of the language system into which they have been born, and which, consciously or unconsciously, they themselves may modify, cannot afford to neglect them.

III. Opposition of vowels (vowel antiphony)

It is the purpose of this essay to attempt a modest contribution to the sound value of some of the English vowels, in particular, to examine the use of vowel antiphony, i.e. of a front and back vowel in opposition (or conjunction), and to suggest that more attention might well be paid to what we might call 'primary' or 'spontaneous' phonology, which, we would contend, is still a living and, at times, creative force in language development.

That there is an innate sense of intrinsic sound values, the following illustration would appear to prove. A nurse, when asked by the writer how she would interpret the sensations of two patients, one of whom was repeating [i:] and the other [o:] or [u:], replied that in the first case the pain would probably be sharper and in the second more deep-seated. Other replies received to the same question were: '[o:] is for a pain which grips you'; '[i:] a stabbing sort of pain'; '[i:] for a sharp pain, [o:] for a dull ache'. We would not contend that pain interjections are the same all the world over. Far from it. A Frenchman, a Russian, a German or an Englishman has his own conventional ways of expressing suffering. But, deeper down than the conventional interjections are the instinctive cries, and in this domain one feels that the nurse's interpretation of the difference in value between the front and back vowel sounds was entirely well-founded. If this is so, there is an appropriateness in the vowel sounds of *itch, twinge, tingle, sting, prick* (cp. Fr. *piquer*) on the one hand and of *ache,* as it was once pronounced [ɑ:k], on the other.[1] (Let it be said, by the way, that there seems no need for our present purpose to distinguish between the sounds [i] and [ɪ].)

The physiological (or psychological) cause of the difference apprehended is not easy to discern with confidence. Is it a matter of greater muscular tension in the case of [i:], and of lesser likelihood of prolongation, corresponding to a sensation that is more acute, and, in general, of short duration or intermittent? Or is it a matter of volume of sound, i.e. of the greater resonance of the back and the greater 'acuteness' of the front vowels? In our view, both these considerations have to be taken into account, either separately or conjointly, in considering this and other aspects of the intrinsic value of vowel antiphony.

IV. Functional values of the 'narrow' vowels

That the lesser resonance of [i] or [ɪ], the 'narrowest' of our vowels, makes them a suitable medium for the linguistic expression of 'minuteness', 'slenderness', and other kindred notions, our language brings abundant evidence. Without labouring a point which is by now pretty generally recognized, one may mention the use of [i] (or [ɪ]) as a diminutive

[1] The vowel [ɑ] (as in *far*), pronounced without tension of the muscles, may express pleasure or relief.

or hypochoristic suffix: *girlie, doggie, auntie*, etc. (It is well known that diminutives and terms of endearment are often the same.) Its chief use is perhaps in nursery English (e.g. *Johnnie, come and warm your handies!*), but it is also a noteworthy feature of the adult speech of certain parts of Scotland. It is no refutation of this 'suitability' to point to its entirely different use as an adjectival suffix (e.g. *weighty, dusty, greasy*, etc.), for language is full of such contrasts: cp. *the cat walks* and *the cats walk*, where the same sign [s] indicates singularity in the verb and plurality in the noun! Our contention is merely that, regardless of the question of origins, there is an 'appropriateness' in the final of *doggie*, etc. which is not felt in that of *weighty*, etc., although there are also some adjectives where the sound value of the final [i] is not without a certain 'appropriateness' analogous to its use in the nouns, e.g. *sugary, velvety*, and the nursery adjective *nicey*.

Let us note, further, that, combined with a great variety of consonants, many of which have very interesting sound values which we must perforce neglect, [i] (or [ɪ]) figures in the body of a vast quantity of words which carry a suggestion of 'minuteness', 'slightness', 'feebleness' or other psychologically allied notions. The following list, the fruits of no very long reflexion, should suffice to exemplify the statement, irrespective of whether this or that word is onomatopoeic in origin or not: *brittle, blink, chink, glitter, flicker, glimmer, glint, giggle* (cp. *gargle*), *titter, whisper, snigger, sneak* (verb of motion), *steal* (id.), *creep, seep, fizzle, slit, slip* (of a girl), (cp. a *slap*-up dinner), *slim, dim, little, ripple, tickle, tipsy, tip, pip, peep, trickle, simmer, shimmer, flimsy, fiddle* (verb), *twiddle, stipple, drizzle, whittle, tinkle, twinkle*. To take the last two examples, one might even say that there is a psychological connexion between *tinkle* and *twinkle* and perhaps, though more remotely, with *tingle*, although the words refer to different sense domains, and part of this connexion is reflected in the stressed vowel [ɪ] which they have in common. In words of this kind, sound and sense are closely interwoven and, as our list shows, such words are not infrequent.

V. Functional sound influences on language development

If this value of [i] (or [ɪ]) is a reality, one would expect to find cases attributable to it of a more active influence upon language development. Is it a pure accident, for example, that Latin *parvus*, 'small', with its broad [ɑ] sound is replaced in the Romance languages by words containing an [i] sound: cp. Rum. *mic* (mare='great'); Ital. *piccolo, piccino*; Span. *chico* (cp. also *pequeño*), Fr. *petit* (cp. ton *'tit* frère)? Or do the present-day equivalents of *parvus* owe their use to the fact that they correspond more in sound to the idea of 'littleness'; just as *tiny* [taini] reverts to the old sound of *i*, viz. [i] (cp. *teeny, teeny weeny*), to provide a more appropriate sound-sense effect, when there is a desire to convey an impression of extreme minuteness? Scots '*mony a mickle maks a muckle*' seems to be another case in point. The word *mickle*, used alone, means 'great', but in the adage it clearly means 'little'. The adage may perhaps be an imitation of the proverb of similar meaning, '*mony a pickle maks a puckle*', where the sound-sense contrasts are just as apparent and expressive, although the interesting reversal of meaning of one of the elements is not present. Or, to take a more topical case, when the newspaper, instead of the usual *R.A.F. makes daylight sweep across the Channel*, prints *daylight swoop*, is it not felt that a *swoop* is a *sweep* of a more effective and deadly character? If so, a present-day etymological relationship between the two words has been set up, a new linguistic nexus

a fact quite as important, philologically, as, say, the ancient mutation *mouse—mice*. Another possible case of sense change under the influence of sound is that of *squint* with the meaning of 'brief glance' (e.g. *let's have a squint*) where the front vowel [ɪ] (and the nasal) may have helped to bring the word into some kind of association with *blink*, *wink*, and *glint*. (English *big* and *small* seem formidable obstacles to establishing the sound and sense correspondence we are suggesting. That there must be, and are, a host of exceptions nobody with any knowledge of the development of languages would think of denying. But *big* and *small* have two vigorous rivals with 'appropriate' vowels in *large* (which should mean 'broad', by the way) and *little*. Note too the vowels of huge, whopping, and enormous. In language viewed as a form of human activity 'etymology' counts for very little. One might rightly say that *enormous* owes its expressive value not to its Latin etymology, but to the fact that it is a resonant vehicle for the vowel [o].)

The pairs *mickle* and *muckle*, *pickle* and *puckle*, *sweep* and *swoop* raise the question of vowel antiphony and its possible uses. Italian has two very common suffixes, *-ino* for diminutives,[1] *-one* for augmentatives, where sound fits sense in a very 'appropriate' manner. Is it too fanciful to see something analogous in the body of some English words? In the case of words connoting types of sound there seems little room for doubt: *creak* and *croak*, *squeak* and *squawk*, *squeal* and *squall*, *clink* and *clank*, are obvious cases where difference in the vowels corresponds to difference in the sense; but are there less imitative cases where sound-symbolism operates by a transference of the ideas of volume or acuteness into other psychological fields than that of sound? What of the following: *sip, sup; drip, drop; slit, slot; slipp(er)y, sloppy; to tip, to tap; tip, top; tipple over, topple over; to chip, to chop; chick, chuck* (familiar for 'hen'); *nibble, nobble; snip, snap;* and even *nip, nab; kitten, cat; tickle, tackle; snivel, snuffle; I'll just peep in for a moment, I'll just pop in for a moment*?

It is no refutation of the 'expressiveness' of the vowel antiphony we would wish to claim for these examples to point to the antiphony in *sneeze* and *snooze*, *knees* and *nose* and many similar examples which might be put forward. A real refutation would be to produce a list of pairs of words possessing the opposite vowel antiphony (i.e. back-front), and yet related or associated in meaning in the manner of the pairs set forth above. The writer cannot think of such a list.

VI. APPLICATIONS OF VOWEL ANTIPHONY BY TRANSFERENCE

We remember having seen quoted the instance of a child, who, on seeing his father clad in an impressive fur coat, exclaimed 'popa!' instead of his usual 'papa'. The following experiment would appear to match this observation and give further proof of the possibility of a transference from the domain of sound to other psychological fields, somewhat as we can get an impression of size from the sound of footsteps passing by. The writer asked a number of persons how they would distribute the names *Tim*, *Tom*, and *Tam* among three dogs, one large, one of medium size and one a puppy. The replies, almost without exception, were, in order of size, Tom, Tam, and Tim![2]

Perhaps the commonest case of vowel opposition in English is that of the 'strong' verbs,

[1] Diminutive suffixes with the vowel [i] are very common indeed, but it is easy to find examples with other vowels: e.g. Fr. *-ot* in *frérot, pâlot*: Rumanian *-uc* as in *tineruc* (v. Al. Rosetti, *Istoria limbii române*, I, 2nd ed., Bucharest 1940, p. 126).

[2] The test is not absolutely conclusive because of the possibility of the association of one or more of these names with individuals known to the persons questioned.

the great majority of which have a back vowel in the past tense: *fling, flung*; *spit, spat*; *sing, sang*, etc. There are of course some noteworthy exceptions, *hit, run, go, do* for example.[1] When one reflects that the past tense shares one of the functions of the Latin Perfectum (the name is significant), which at times is formed by what must have been originally an entirely 'expressive' device, namely, reduplication (e.g. *tango, tetigi*, etc.) is it not possible that the expressive contrast formed by the greater volume of the back vowel has been a contributory factor in the development of our 'strong' verbs? In the past tense, the action denoted by the verb is completed or achieved, and therefore can be more fully visualized or 'realized' than in other tenses: cp. *I flung, I spat*, with *I fling, I shall fling*, etc. It is difficult to believe that these antiphonies are purely accidental or due solely to the mechanical working of 'sound laws'. It is relevant in this connexion to remind the reader that the *d* or *-ed* of the past tense of 'weak' verbs is a remnant of the verb *to do*.

VII. The *this-that* antiphony

An attempt, not a very convincing one, be it said, has been made in a recent article (T. K. Davis (1938), "Sounds in language", *J. Nerv. Ment. Dis.* **88**, 496) to link up this phenomenon of the change of vowel in the past tense of verbs with another case of vowel antiphony to be found in a great variety of languages, namely, the use of [i] in words denoting 'nearness' and of a more rearward vowel in those denoting 'remoteness'; cf. Fr. *ici, là;* Engl. *this, that;* Germ. *hier, da;* Malay, *ili* (this), *ika* (that), (a little removed), *iku* (farther away) (op. cit., ibid.). The author, who shows a lack of linguistic training, compares the last example with *sing, sang, sung*, etc., forgetting that *I have sung* is frequently less 'remote' than *I sang*. "The analogy is simple", he says, "the present tense 'i' is here, the past tense 'a' is there, and the pluperfect (*sic*!) 'u' is yet more removed."

The author's contention, though specious, appears to us unsound, not only in detail but in general. It behoves us therefore to attempt an explanation of this widely used *this-that* antiphony. Harking back to the nurse's interpretation of the use of [i] to express pain that is acute, the reader will perhaps remember that we suggested that both muscular tension of the vocal organs and lesser volume of sound should be taken into consideration in accounting for this phenomenon. We think it possible that the *this-that, hier-da* antiphony can be accounted for on the same lines. What is *here* is, so to speak, within our grasp and more 'acutely' realized than what is *there*, and, spatially, what is *here* is close to us, while there may be all the world between us and what is *there*.

VIII. Other 'front-back' antiphonies

There is, in general, an undoubted sense of satisfaction, shared, apparently, by one of the humbler quadrupeds, in the utterance of the 'front-back' vowel antiphony, whether it is because of the tension and release experience in a sequence like [i]-[ɑ], or because there is a sense of climax in finishing a word or sentence with a sound of substantial volume. Possibly both causes come into play. If French *ad-mi-rable!*, and *for-mi-dable!* are infinitely more expressive than their English equivalents, it is clearly due to the full-stressed final syllable which is thrown into full relief by the preceding 'narrow' [i]. If

[1] Note the vowels of some of the popular equivalents for *to hit*: *clout, slog, slosh, sock, bang, bash, wallop, flog*; but *biff*.

we say *safe and sound, bound hand and foot, lead a cat and dog's life*, where the French invert the order and say: *sain et sauf, pieds et poings liés, s'entendre comme chien et chat* (but *aller et venir, va-et-vient* for 'to come and go', 'coming and going'), one sees no other reason than that the front-back sequence is more satisfying. It would be an interesting inquiry to examine how far this tendency prevails in word order, whether in the formation of compounds of a more or less whimsical kind, or of set phrases: e.g. *gimcrack, slipshod, topsy-turvy, whipper-snapper, thingummy-bob* (which rivals *thingummy-jig*), *tiddly-brat, brick-bat, ragamuffin, ragtag-and-bobtail, rigmarole, kittle cattle, merry and bright, spick and span, happy-go-lucky, for ever and for aye*, etc.

IX. Repetitive antiphonies

Finally, to come to perhaps the most difficult problem, which we cannot claim to have solved even to our own satisfaction, what of the series, if series it be, *tittle-tattle, pitter-patter, tic-toc, ding-dong, see-saw, sing-song, ping-pong, dilly-dally, shilly-shally, zig-zag, tit for tat, jim-jams, riff-raff, knick-knacks*? And what of *slip-slop, tip-top, wishy-washy*? What too of French *cahin-caha, clopin-clopant, trictrac* ('backgammon'), *bric-à-brac, ric-à-rac* ('just barely enough'), *tic-tac, répondre du tic au tac* ('to answer pat') *et patati et patata* ('and so on and so forth'), *méli-mélo* ('mix-up', 'jumble'), *zig-zag, pif-paf* ('blows'), *mic-mac* ('dirty work', 'scheming')? It might be said that the change of vowel in the second element of these twin compounds is merely due to an inherent dislike of pure repetition and a search more for the picturesque than the pictorial. The series of twin compounds where it is the initial consonant that changes lends colour to this view: *hotch-potch, hugger-mugger, hanky-panky, harum-scarum, hurry-scurry, helter-skelter, hurly-burly, hurdy-gurdy, holus-bolus, hokey-pokey, hocus-pocus, hoity-toity, humdrum, higgledy-piggledy, namby-pamby, fuzzy-wuzzy, razzle-dazzle, roly-poly*. To find a formula to cover all the examples of this whimsical side of language is clearly impossible. But it seems to us that in the *majority* of cases each twin of the compounds with consonant change is, so to speak, on the same level (except when some familiar word or piece of a word protrudes and catches the mind's eye), so that one element appears rather as a variant of the other; whereas in the twins with vowel antiphony, which are our present concern, the level varies, and there is a certain sense of opposition, which brings us close to the domain of the *this-that* antiphony, a likeness most noticeable perhaps in *tit-for-tat*.

However that may be, starting from the idea of 'repetition but with a difference' we can bring a certain order into the English group, despite the varying degrees of onomatopoeic 'imitativeness' its members display. *Tittle-tattle, pitter-patter, tic-toc, ding-dong, sing-song*, and *ping-pong* seem to belong together. And as *ding-dong* can be used as an adjective, e.g. *ding-dong struggle*, 'a struggle in which the decision sways this way and that', the transference from 'quasi-repetitive sound' to 'a to-and-fro motion' seems a possible one for the mind to make. This would account therefore for *see-saw* and *zig-zag*. But it seems a broad psychological leap to go from this to 'a number of small objects of roughly similar size and of varying shapes' as in *knick-knacks*; yet both English and French (*bric-à-brac*) seem to have taken it. Compared with this, in *dilly-dally* and *shilly-shally* the transference from 'quasi-repetition' to 'doing this and that', 'hesitation', 'trifling', doing neither this nor that', would seem a fairly easy feat. *Slip-slop* and *wishy-washy* do not seem too remote from this scheme, and as for *tip-top* it may merely

be a pure superlative with the 'satisfying' 'front-back' sequence.[1] For *jim-jams* and *riff-raff* we can offer no plausible explanation.

In the French group, we have 'quasi-repetition' in *tic-tac* (for watches and clocks), and *et patati et patata*, which is somewhat of the same nature as *tittle-tattle*, 'alternation' in *zig-zag*, *pif-paf*, 'uneven movement' in *cahin-caha* ('jogging along') and *clopin-clopant* ('hobbling along'), 'disorder' in *méli-mélo* ('mix-up'), and 'under-hand activity', 'goings-on' in *mic-mac*. *Répondre du tic au tac* seems to have some analogy with *tit-for-tat*, *ric-à-rac* is of the same order; as for *trictrac*, a knowledge of the game of backgammon might perhaps supply the solution we have sought in vain.

The problem is not made any simpler by the fact that, as in the *hurry-scurry* series, both the English and French groups with vowel antiphony contain examples reminiscent of, or identical with, other less 'expressive' words, e.g. *patter*, *sing*, *song*, *see*, *saw*, *shall* (?) (cp. *willy*-nilly), *wash*; Old Fr. *clop*, 'lame', mod. Fr. *cahot*, *cahoter*, *mêler*.

X. Summary and conclusion

To sum up, there is a feeling of satisfaction in the utterance of the 'front-back' vowel sequence, due, possibly, both to the release of muscular tension[2] (cp. *peep-bo*, *heave-ho* and the winding-up effect and subsequent explosion in *hip*, *hip*, *hip*, *hooray!*), and to the mere contrast in volume or resonance. The difference in tension and sonority has also a symbolic, one might almost say pictorial value, due to some process of psychological transference as witnessed in examples quoted above.

The writer is fully conscious of the lack of finality in an essay of this kind; of the numerous exceptions which render it impossible to formulate anything like a law in this capricious domain of the unruly world of language; and of the ever-present danger of self-persuasion and subjectivity in the matter of symbolic representation. There are people who find a thrill in the useless and unetymological *h* of *ghost*, and a seventeenth-century Frenchman is said to have found a pictorial value in the *h* of *houlette*, 'a shepherd's crook'. To quote a more modern instance: "Si l'on supprimait l'o de paon", said Leconte de Lisle, "je ne verrais plus cet oiseau faire la roue." None the less, and although Little Bo-peep, and Jack and Jill find favour in the nursery beside Old Mother Slipper Slopper and Dickery-dickery-dock, the writer is convinced that the spontaneous use of the sound values of vowel antiphony, particularly of the front-back sequence, is a reality. Long before he ever turned his attention to the matter he had ventured to make up a nursery poem of which the rival heroes were Slippery Dick and Slobbery Sam. And, as an appropriate ending to a soporific article, he would affirm that he cannot help seeing a picture of the staccato movements and final droop of a drowsy head in:

> We're a' noddin', a-nid-nid-noddin',
> We're a' noddin', we want to go to bed.

[1] It is interesting to note that for the sounds of a watch and a small bell '*tick-tick*' and '*ting-a-ling*' are used (cf. Fr. *din-din*), doubtless because the respective sounds are small in volume and are repeated in close succession.

[2] An analogous release can be obtained from an [ɑ] following upon a rounded back vowel as in *houp-là*.

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A FACTORIAL STUDY OF PICTURE TESTS FOR YOUNG CHILDREN[1]

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I. *Introduction* (pp. 9–10). II. *Experimental procedure* (p. 10). III. *General results of tests* (pp. 10–11). IV. *The factorial analysis* (pp. 11–12). V. *Rotation and interpretation of factors* (pp. 12–14). VI. *Summary and conclusions* (p. 15). *References* (p. 16).

I. Introduction

The following investigation was undertaken in the course of the construction of a Group Picture Intelligence Test for seven-year-olds. Many factorial studies have been performed with groups of adult subjects and older school children, but so far as the writer is aware no such work has been done with subjects as young as this. She considered, however, that it would be of considerable interest and value to find out whether a mixed battery of tests given to children of this age would be explicable in terms of one general factor and specifics only, or whether it would show differentiation into the widely accepted group factors, verbal, number, space, etc. For there has, as Prof. G. H. Thomson (1) has pointed out, been a general tendency noticeable in experimental reports to the effect that batteries of tests do not permit of being explained by as small a number of factors in adults as in children.

The writer is of the opinion that the action of some kind of 'bonds' as discussed by Prof. Thomson ((1), pp. 270–1) is the best explanation that can be given of the factors obtained by analysis, and that these bonds act in the early years in an entirely undifferentiated fashion, leading to the appearance of one general factor only when the intercorrelations of tests given to young children are analysed; while education and vocation impose in later years a structure that is absent in the young, leading to matrices of intercorrelations of tests that depart further and further from rank 1 as the subjects tested become older.

By the age of 7 years of course children have been in school for 2 years, and acquired the beginnings of both reading and number, so that it might be expected that the verbal and number factors would also have made some appearance, though possibly not very clearly. It would also be necessary to look for a space factor, which is probably to be identified with W. P. Alexander's '*F*' factor (2) of practical ability. Alexander claims that this factor can be estimated at 11 years old, and used as a valuable indication of the type of post-primary course which any child should follow. Patrick Slater (3), on the other hand, has found it difficult to obtain a reliable estimate of any spatial factor at 11 years old, using tests which do provide such an estimate at older ages, and that still give a satisfactory score scatter with the younger subjects. In his latest experiment (4) in fact he finds that even at 13 years old a battery including intelligence, verbal and spatial tests is sufficient only to define a general and a verbal factor with no trace of a spatial one. If this is so then there will almost certainly be no indication of such a factor separate from

[1] Taken from a thesis accepted in fulfilment of the requirements for the degree of Doctor of Philosophy, University of Edinburgh.

the general factor at the still younger age of 7, but if it is as clear at 11 years old as Alexander believes, then it might also be present at any younger age.

II. Experimental procedure

The picture tests used in the investigation were all newly constructed for the purpose. They consisted of:

(1*a*) A Substitution Test of the usual form, putting the correct symbol under various drawings.
(2*a*) A Classification Test, where the child had to pick out two drawings similar to three given samples.
(3*a*) An Absurdities Test, where the child is asked to mark all drawings that have something wrong or silly about them.
(4*a*) A Memory Span Test, in which the task was to mark from among all the drawings in a line those named by the examiner.
(5*a*) A Series Test, consisting of completing various patterns of crosses and rings.
(6*a*) An Analogies Test in picture form.
(7*a*) A Block Counting Test, to write under various piles of bricks how many there are in each.
(1*b*) A Directions Test, for following exact instructions.
(2*b*) A 'Doesn't Belong' Test, in which the one drawing in each line different from the others has to be marked.
(3*b*) An 'Always Has' Test, in which the two things the first picture always has or must have are to be marked.
(4*b*) A Completion Test, where the child marks the part that is missing from a sample drawing.
(5*b*) A Sequence Test, in which four or five drawings must be mentally put in their correct order and the first and last of this order marked.
(6*b*) A Reversed Similarities Test, where the task is to pick out the mirror image of the given drawing.
(7*b*) A Mazes Test, to trace the path from a mouse in the first maze to a piece of cheese in the last.

It was considered that this battery should be quite adequate to define both a general and a space factor if such were operative at this age. In order to help define verbal and number factors if such were to be found, school records of reading and arithmetic quotients by the Vernon(5) graded word-reading test and the Ballard(6) 1 min. addition and subtraction tests were added to the battery. These would not be in themselves sufficient to define a verbal or a number factor, but it was hoped that they would help them to show if they were present in the rest of the battery. The difficulties of giving group verbal or number tests to such young children, and the impossibility of testing individually the 500 or so cases included in the experiment, prevented us from having any further such tests in the battery.

The instructions of the picture tests were carefully standardized, and the tests put together in two booklets. The children were tested in groups of 25 by the experimenter or the Infant school Mistress, each with an assistant, and all the children did Tests 1*a*–7*a* first, followed by Tests 1*b*–7*b* at intervals of from 1 to 3 weeks.

The children tested were some 500 boys and girls aged 6 years 7 months to 7 years 6 months inclusive at date of test. They came from seven Primary schools in Edinburgh and formed a very representative sample of the city population. The final group which took both sets of picture tests and the reading and arithmetic tests numbered 414, 218 boys and 196 girls.

III. General results of tests

The Classification Test proved much too difficult for the children and was dropped altogether from the battery. Significant sex differences appeared for the Block Counting and the Mazes Tests, but in all others there was less than one point of raw score difference

between the mean for boys and girls. The boys' and girls' results were kept separate throughout the analysis: the Mazes Test in fact proved so difficult for the girls that it had to be abandoned altogether in the analysis of their results. The final battery for analysis was therefore for the boys:

1. Substitution
2. Absurdities
3. Memory Span
4. Series
5. Analogies
6. Block Counting
7. Directions
8. Doesn't Belong
9. Always Has
10. Completion
11. Sequence
12. Reversed Similarities
13. Mazes
14. Reading
15. Arithmetic.

For the girls the tests were just the same except for the omission of no. 13, Mazes.

The intercorrelations of the tests were calculated by the product-moment formula, using the diagonal adding method. These are shown in Table 1.

Table 1. *Intercorrelations of tests*

Boys

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	—	354	313	307	208	017	247	248	139	284	248	285	232	−012	157
2.	254	—	393	342	451	145	256	428	325	387	420	423	341	192	140
3.	205	406	—	313	241	103	207	299	180	243	293	321	068	205	179
4.	133	381	331	—	392	397	212	388	364	429	452	503	385	260	247
5.	318	440	283	318	—	201	175	385	321	345	351	453	334	173	157
6.	086	233	151	140	171	—	233	229	149	322	245	308	297	200	212
7.	242	340	233	412	333	113	—	275	280	356	273	358	309	190	235
8.	165	452	300	467	440	220	297	—	373	409	514	428	280	222	166
9.	246	378	178	379	428	166	275	451	—	497	363	441	294	215	268
10.	249	452	327	462	441	213	384	430	377	—	407	557	395	261	302
11.	204	381	262	413	384	188	310	535	345	402	—	515	304	252	313
12.	253	376	225	470	437	188	444	424	440	407	471	—	451	248	207
13.	—	—	—	—	—	—	—	—	—	—	—	—	—	133	099
14.	018	063	157	171	197	009	277	244	206	163	119	210	—	—	541
15.	106	094	106	220	170	164	292	205	069	192	245	180	—	565	—

Girls

N.B. All decimal points are omitted from this table.

IV. THE FACTORIAL ANALYSIS

Thurstone's centroid process with guessed communalities in the diagonal cells was used for the analysis. The boys' and girls' batteries were analysed separately, three factors being taken out in each case. The loadings obtained are shown in Table 2 below.

Table 2. *Centroid factor loadings*

	Boys				Girls			
	I	*II*	*III*	h^2	*I*	*II*	*III*	h^2
1.	0·408	0·155	0·222	0·240	0·368	0·083	−0·199	0·182
2.	0·609	0·217	0·210	0·463	0·619	0·297	0·095	0·480
3.	0·453	−0·064	0·295	0·296	0·470	0·086	0·160	0·254
4.	0·663	−0·105	−0·225	0·502	0·631	0·139	0·128	0·411
5.	0·560	0·134	−0·078	0·338	0·632	0·141	−0·201	0·460
6.	0·417	−0·195	−0·308	0·307	0·292	0·080	0·172	0·121
7.	0·478	0·053	0·062	0·236	0·579	−0·135	−0·112	0·366
8.	0·622	0·149	0·127	0·426	0·680	0·152	0·132	0·503
9.	0·568	0·123	−0·096	0·347	0·578	0·198	−0·262	0·442
10.	0·694	0·103	−0·143	0·513	0·652	0·138	0·042	0·447
11.	0·660	0·042	0·107	−0·448	0·631	0·139	0·128	0·434
12.	0·731	0·174	−0·148	0·587	0·658	0·074	−0·194	0·476
13.	0·528	0·220	−0·261	0·396	—	—	—	—
14.	0·437	−0·506	0·093	0·456	0·390	−0·615	−0·074	0·535
15.	0·455	−0·461	0·152	0·442	0·417	−0·606	0·161	0·567
Variance taken out	4·737	0·743	0·515	5·995	4·330	1·002	0·345	5·676

The first factor is clearly a general factor running through the whole battery, the second shows a sharp division between the scholastic and the picture tests, and the third a division among the picture tests themselves. But the third factor is not the same for the boys and girls. For the boys Substitution, Absurdities and Memory group together at one end, and Series, Block Counting, Mazes, with possibly Completion and Reversed Similarities at the other. For the girls the division is Substitution, Analogies, Always Has, and possibly Reversed Similarities at the one end, and the remainder fairly closely together at the other. All the loadings in this factor were actually very small, none reaching as much as 0·30, and the average residual after extracting two factors was only 0·0395. It was suspected therefore that this third factor in the girls' battery might not be significant.

An analysis was also made of the picture tests alone to find out if in this way divisions among them would show up more clearly. Three factors were again taken out both for boys and for girls. It was found that in each case the second factor was almost exactly the same as the third factor in the complete analysis: also that the new third factor here taken out for the boys corresponded very closely to the girls' third factor in the complete analysis. The dropping of the reading and arithmetic tests therefore had merely caused one dimension to drop out from the analysis; and it seemed clear that there was a dimension represented in the boys' tests which was missing from the girls' battery.

In order to test the significance of the factors obtained it was decided to fit one factor to the intercorrelations of the picture tests by Mr D. N. Lawley's(7) 'maximum likelihood' method. The advantage of this method is that it allows of a satisfactory mathematical determination of how many factors are necessary to explain the correlations obtained. After calculating the first residuals for the girls, the measure 'w', by which their significance is tested, was found to be (with 196 cases) 62·387. With 12 tests and 1 factor, d.f. = 54, and χ^2 at the 1 % point = 83·5, at the 5 % point = 75·6. Thus the obtained value of 'w' does not reach even the 5 % significance level. Therefore, although we cannot state definitely that only one factor is present in the picture tests for the girls, we have no reason to assume more than one, or more than two in the complete battery.

When one factor was similarly fitted to the boys' data, with 218 cases, 13 tests, and 1 factor, $w = 115{\cdot}65$, d.f. = 65, and χ^2 at the 1 % point = 79·03. There is no doubt whatever therefore that a second factor is needed to explain the data. Since the third factor for the boys' picture tests was the same as the second for the girls, which had already been found not to be significant, there was no need to do any further tests with the boys' data.

We were left therefore with three significant factors in the complete battery of boys' tests, two among the picture tests, and for the girls two significant factors in the complete battery, one only in the picture tests.

V. Rotation and interpretation of factors

Rotation of the centroid factor matrices is necessary before a psychologically meaningful structure will appear. For this purpose diagrams were made showing the positions of the various tests with regard to the centroid axes for both boys and girls. From these diagrams it was clear that it would be impossible to eliminate completely a general factor and so attain simple structure unless the axes were placed at an oblique angle. In this case the factors would be correlated with each other and, it seems to the writer, would lose much of their value in giving a simplified explanation of the test scores.

In the case of both boys and girls the second factor is largely defined by the reading and arithmetic tests. The first axis was therefore so placed in both cases as to obtain the maximum loadings of these tests in the second factor, while at the same time no significant negative loadings were allowed to remain for the picture tests, and as many as possible were made zero. A rotation of 20° in both cases achieved this.

As there was one further significant factor for the boys, a diagram of I_1 and III_0 was made. The question here arose as to whether the axis should be so placed as to give high loadings to the tests at the positive or to those at the negative pole of the centroid factor. The highest positive loading is 0·30, the highest negative 0·31, so that there is nothing in this to show which is better. A positive rotation however would give high loadings to Block Counting and Mazes, the two tests in which the boys did better than the girls. It seemed reasonable to suppose that a factor found in the boys' results but not in the girls' should be largely concerned with these two tests. This rotation also made it possible to eliminate four tests from the third factor, while a negative rotation would only eliminate one unless some significant negative loadings were allowed to remain. A rotation of 30° in the positive direction was therefore adopted.

The rotated factor matrices for both boys and girls are shown in Table 3 below.

Table 3. *Rotated factor loadings*

	Boys				Girls		
	I_2	II_1	III_1	h^2	I_1	II_1	h^2
1.	0·488	−0·077	0·026	0·240	0·374	0·048	0·142
2.	0·665	0·004	0·142	0·463	0·683	−0·067	0·471
3.	0·497	0·215	−0·054	0·296	0·471	0·080	0·228
4.	0·396	0·325	0·489	0·501	0·608	0·163	0·396
5.	0·456	0·066	0·354	0·337	0·643	0·081	0·420
6.	0·128	0·326	0·429	0·306	0·302	0·025	0·092
7.	0·436	0·114	0·180	0·236	0·498	0·323	0·352
8.	0·614	0·073	0·208	0·426	0·691	0·090	0·477
9.	0·450	0·079	0·371	0·347	0·611	0·011	0·373
10.	0·524	0·140	0·468	0·513	0·660	0·093	0·444
11.	0·603	0·187	0·224	0·448	0·641	0·085	0·418
12.	0·573	0·086	0·502	0·587	0·643	0·155	0·437
13.	0·364	−0·026	0·512	0·396	—	—	—
14.	0·253	0·626	0·038	0·457	0·156	0·711	0·530
15.	0·309	0·589	0·003	0·442	0·185	0·712	0·541

The first factor for both boys and girls is then a general factor present in all the picture tests and also slightly, at least for the boys, in the reading and arithmetic tests; the loadings of these two in the case of the girls are barely significant, both being under 0·2. We may probably say that it shows at least an approximation to the pure '*g*' loadings of the tests, though it may also involve some other factor or factors which the battery has proved itself inadequate to define, particularly in the case of the girls, where no other significant factor has appeared among the picture tests.

The second factor, defined largely by the reading and arithmetic tests, is clearly a school learning factor of some kind, possibly of a mixed verbal-number nature since it seems to appear equally in both tests, more probably something to do with the fact that both are concerned with something which has been actually taught in school, while the picture tests are not. The two picture tests with loadings above 0·3 in this factor for the boys are Series and Block Counting. Both these seem to have something in common with arithmetic, the counting of blocks, and probably counting the rings and crosses in the Series Test. The only other significant loading is in the Memory Test (0·22) in which the children

had to look at a row of pictures and then cross out the ones mentioned by the examiner; the number to be remembered at once increased gradually from two in the first item to seven in the last. The writer's own method of remembering disconnected lists such as this is to count how *many* items are to be reproduced, and then afterwards use auditory images of the actual words to reach the required number. Some such process as this may lead to a slight loading in this number-verbal factor for the Memory Span Test, or it may be that memory is in itself in some way involved in the factor, for it certainly plays a large part in the early stages of reading and mechanical arithmetic.

In the case of the girls, the only picture test with a significant loading in the second factor is Directions (0·32). Clearly, as for the boys, this is a school learning factor of some kind, the loadings in reading and arithmetic being high and equal. But whereas for the boys it seems from the presence of Series and Block Counting to be rather a number than a verbal factor, for the girls it seems to be rather verbal than number, for Series and Block Counting are both absent, while the Directions Test chiefly involves the comprehension and remembering of precise verbal instructions.

No further significant factor appeared for the girls, but for the boys a third factor was proved significant. This factor has high loadings, in this order, in Mazes, Reversed Similarities, Series, Completion, Block Counting, Always Has and Analogies; low, but probably significant, loadings in Doesn't Belong and Sequence; and is absent from Substitution, Memory, Reading and Arithmetic; and almost absent from Absurdities and Directions. This very definitely suggests that it is a space factor, involving ability to manipulate given material through visualization, without any overt manipulation. Such an ability would have little to do with success in any of the tests not present in this factor, and would obviously be of great use in almost all those which have a significant positive loading. The most puzzling test present in the factor is Analogies, which involves not seeing something directly in the presented pictures, but a relationship between two of them; moreover the instructions for the test are such that the child is encouraged always to verbalize the relationship. In spite of this, however, the writer is inclined to identify this factor as a space factor.

Perhaps the most interesting fact that emerges is that whereas two common factors, a general and a space factor, are needed in addition to specifics to explain the scores of the boys in the picture tests, one general factor alone, along with the specifics, is sufficient to account for the girls' scores. It seems as if the space factor is entirely lacking in girls at this age. One of the tests by which it is defined, Mazes, is missing from the girls' battery, but the remaining ones should have been sufficient to show it up had it been present, without allowing it to become absorbed in either the general factor or one of the specifics. In the Block Counting and Mazes Tests the boys did significantly better than the girls, but in the Reversed Similarities and other tests with significant loadings in the space factor for the boys, there was no difference between the mean scores for boys and girls. This seems to indicate that the girls, even if lacking in the visual-manipulative ability possessed by the boys, can yet succeed in these tests by the exercise of their general intellectual ability. Indeed it seems clear that different individuals do perform the same task in different ways, and that the factorial composition of any test, while it must, if our analyses have any objective factual basis, remain invariant for the same or similar groups of subjects, might yet vary considerably with groups dissimilar in sex, age, or environment.

VI. SUMMARY AND CONCLUSIONS

A battery of 14 picture tests, a word reading test, and a mechanical arithmetic test was given to a group of 414 seven-year-old elementary school children, 218 boys and 196 girls. The intercorrelations of test scores, both of the complete battery and of the picture tests alone, were analysed by Thurstone's centroid method into three common factors and specifics, separately for boys and girls. Fitting one factor by the maximum likelihood method to the picture test results both for boys and girls showed that one general factor and specifics were sufficient to explain the girls' picture test scores and two common factors and specifics their scores in the complete battery, while for the boys two common factors and specifics were needed to explain the picture test scores, three common factors and specifics for the scores in the complete battery.

The centroid factor matrices were then rotated to eliminate negative loadings and obtain as many zero loadings as possible. The first factor in every case was found to be a general factor present in all the picture tests, and slightly in the scholastic tests. It was impossible to eliminate this general factor without either allowing significant negative loadings in some factors, or else departing from the principle of orthogonal factors. The presence of a general factor was therefore accepted.

The second factor present in the complete battery but not present when the picture tests alone were analysed, was identified as a scholastic factor of a mixed number-verbal nature and possibly slightly influenced by memory. From the slight loadings of the picture tests in this factor it was suggested that it tended to be rather more number than verbal for the boys but rather more verbal for the girls.

The factor appearing third in the complete battery for the boys, second among the picture tests but not present at all in the girls' results, was identified as a space factor. In two of the tests with loadings in this factor, Block Counting and Mazes, the boys did better than the girls, but in the remaining ones there was no significant sex difference. It seemed therefore that the absence of a space factor in girls of this age prevented their being able to do these two tests as well as the boys; but the other tests involving a space factor for the boys were equally well performed by the girls by means of their general intellectual ability.

No conclusions can be drawn as to whether girls are altogether lacking in the ability indicated by the space factor, or whether this ability is merely later in appearing for the girls than for the boys. It was, however, found in a large-scale experiment with tests in an English County Borough prior to the Scottish Mental Survey (8) of 1932 that a block-counting test was useless as a measure of general intelligence at 11 years old because of a significant sex difference in favour of the boys. There is also a general tendency noticeable for boys to do better than girls in tests of mechanical ability, which is probably very largely dependent on spatial judgement. It seems therefore that even if the space factor does appear among girls at a later age it is still in a less degree than for the boys.

Our general conclusions are therefore that at 7 years old there is a general intellectual factor operative in girls and boys; that there is already a scholastic factor, distinct from the general factor, and possibly resulting from two year's experience of school learning; and that a space factor distinct from the above is already present among boys, but that there is no sign of such a factor among girls whether it may appear at a later age or not.

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MEMORY FOR POSITION, AMONG CHILDREN, AS MEASURED BY SERIAL REPRODUCTION

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I. *The problem* (p. 17). II. *Procedure* (pp. 17–19): (1) *Subjects* (p. 17); (2) *Materials* (p. 17); (3) *Method* (p. 18); (4) *Scoring* (p. 18); (5) *Construction of the memographs* (p. 19). III. *Results* (pp. 19–23); (1) *Copying the dot* (p. 19); (2) *Copying versus memory results* (pp. 19–21); (3) *The memograph results* (pp. 21–23); (4) *Reliability of the differences between the subgroups* (p. 23). IV. *Summary and conclusions* (pp. 23–24). *References* (p. 24).

I. The problem

Bartlett in his book, *Remembering*, discusses the method of serial reproduction which he "designed to study the effect of the combination of changes brought about by many different people" ((1), p. 118). The method is briefly described by him as follows: "...*A*'s reproduction is now itself reproduced by *B*, whose version is subsequently dealt with by *C*, and so on. In this way chains of reproduction were obtained: (i) of folk stories, (ii) of descriptive and argumentative prose passages, and (iii) of picture material" ((1), p. 119).

The purpose of this paper is a three-fold one: (1) to employ the method of serial reproduction in order to study memory for position, (2) to introduce to the literature an original graphic technique, simple but effective, for presenting the path taken by the memory traces[1] after several filled time intervals, and (3) to determine whether statistically reliable differences exist in memory for position between boys and girls, white and coloured races, older and younger children, and those of higher and lower mental ability (as measured by I.Q. upon a group verbal intelligence test administered by the local board of education).

II. Procedure

(1) *Subjects*

The subjects were sixty children in Grade VI ranging in age from 125 to 181 months with a mean of 142·8 months. I.Q.'s ranged from 75 to 120 with a mean of 95·8 points. Half the children were coloured and half white; half were boys and half girls. This was accomplished as follows: All the children in one classroom were taken as subjects. There were 24 girls and 20 boys; 21 coloured and 23 white children. Another classroom teacher (teaching the same grade in the same school) was asked to begin with the first child (sitting in the first seat of the first row) and take the others in order until she had selected 16 children—six to be girls and ten to be boys; nine to be coloured and seven to be white.

(2) *Materials*

These consisted chiefly of a quantity of sheets of paper 28 cm. long and 21·6 cm. wide. A stop-watch was used in allowing the children to study the location or position of a dot made by the preceding child for 10 sec.

[1] Like Hanawalt ((2), p. 5), "In using the concept of memory trace, we assume no definite physiological theory. A change in the physiological structure of the organism is assumed on the basis of subsequent behavior."

(3) *Method*

Step I—Copying. All subjects were presented with a paper upon which had been placed a pencilled 1 mm. dot equidistant from the sides and top; namely, 10·8 cm. The subject was required to copy the dot from this stimulus paper on to another paper of the same size (to be known henceforth as the copy paper) in exactly the same location.

The directions for this step were: "Here is a sheet of paper with a dot on it. Here is another sheet of paper of the same size. See if you can make a dot on this sheet exactly where you see the dot on the first paper. You are to measure only with your eyes."

Step II—Serial reproduction. The first subject was presented with the stimulus paper and told to study the location of the dot for 10 sec. The stimulus paper was removed and, after a filled time interval, the subject was required to reproduce the dot in exactly the same place upon a clean sheet of paper of the same size. This paper (to be known as the memory paper) was presented to the second subject who studied it for 10 sec. and who, too, after a similarly filled time interval reproduced the position of the dot from memory. This meant, of course, that the memory paper for each subject served as the stimulus paper for the next subject.

The order of testing was done according to chance—determined by assigning to each subject a number and asking a child to mix up in a hat the sixty small tags upon which were written the various numbers. The order in which the tags were drawn from the hat determined the order of testing. This was done for each interval so that the order of testing was different each time.

The filled time intervals were of the following duration: (*a*) 30 sec., (*b*) 1 min., (*c*) 2 min., (*d*) 4 min., (*e*) 8 min., and (*f*) 16 min. These intervals were filled by having the subject return to his regular school work. The 30 sec. interval, of course, consisted of hardly more than letting the subject return to his seat and then recalling him. All of the children took part in all experiments with all time intervals.

The directions for this step were: "Here is a sheet of paper on which is a dot. You are to study the location of this dot for 10 sec. and then you will be asked to make a dot in exactly the same place on another sheet of paper of the same size."

(4) *Scoring*

(*a*) *The copy papers.* In order to score these papers a pin prick was made in the centre of the dot on the stimulus paper. This paper was then placed upon each of the copy papers and a pin point was pressed through the pricked hole so that another pin hole was made upon the copy paper. The area around the second pin hole (indicating the position of the stimulus dot) was coloured with red crayon to make it more easily seen. The distance in millimetres between the centre of this red dot and the centre of the black one made by the subject represents the amount of deviation of the copy from the true location as found on the stimulus paper.

(*b*) *The memory papers.* A pin prick was made through each black dot on the preceding memory paper on to the next subject's memory paper. The distance between the pin prick and the centre of the dot made by the subject represents the amount of deviation which took place after each time interval.

(5) *Construction of the memographs*

In order to show the path (distance and direction) taken by the memory trace of each subject, the following technique was employed: The stimulus paper was placed upon a blank sheet of paper of the same size (called the 'memograph' paper) and a pin prick made through the stimulus dot. Then the memory paper of the first subject was placed upon the memograph paper and a pin prick made through the memory dot. A line drawn from the first to the second pin prick indicated the direction and distance 'forgotten' by the first subject. A line drawn from the second pin hole to the third one (made by pricking the memory dot of the second subject) showed the same effects for that individual. In this manner, serial memographs were made for each time interval showing the direction and amount of deviation which occurred for all sixty subjects.

It may be stated, in passing, that it is possible to construct successive or repeated memographs; i.e. memographs for single persons who had been required to repeat a reproduction a number of times after various time intervals.

III. RESULTS

(1) *Copying the dot*

Table 1 reveals that in copying the position of a dot, located equidistant from the top and sides of a paper $28 \times 21{\cdot}6$ cm., the mean deviation for all the subjects from the true position amounted to 12·70 mm. It also shows that no reliable differences existed between the sexes, the races, the older and younger subjects, and those of higher and lower I.Q. Two footnotes indicate that significant differences were found between the age and I.Q. groups for these two factors.

Table 1. *Copying results*

	N	Mean	S.D.	C.R.
Entire group	60	12·70	7·38	—
Sex: Male	30	12·86	5·86	0·21
Female	30	12·48	8·88	
Race: White	30	12·53	6·61	0·20
Negro	30	12·80	7·44	
Age*: Older	30	12·99	8·87	0·39
Younger	30	12·20	6·08	
I.Q.†: High	30	12·33	6·71	0·31
Low	30	12·90	7·44	

* Older group: range 140–181 months, mean 151·2 months, standard deviation 10·20; younger group: range 125–140 months, mean 134·4 months, standard deviation 4·49; C.R. 8·23.

† High group: range 94–120 months, mean 106·13 months, standard deviation 7·46; low group: range 75–94 months, mean 86·93 months, standard deviation 5·59; C.R. 11·29.

(2) *Copying versus memory results*

Table 2 discloses that, after a 30 sec. and a 1 min. time interval, there was no significant difference in means between the copy error (12·70 mm.) and the memory error (15·40 mm. for the 30 sec. and 17·70 mm. for the 1 min. intervals). After the 2 min. interval, and consistently thereafter, a reliable difference was found to exist between the means of the copy errors and the memory errors.

Table 2. *Reliability of the differences between copy and memory errors*

Copy errors		Memory errors			
Mean	S.D.	Time interval	Mean	S.D.	C.R.
12·70	7·38	30 sec.	15·40	9·56	1·74
		1 min.	17·70	20·30	1·80
		2 min.	20·01	16·64	3·11
		4 min.	21·00	16·48	3·56
		8 min.	23·16	21·09	3·79
		16 min.	23·87	18·88	3·52

Strictly speaking, these errors are not memory errors in the sense that they are solely due to forgetting, for it has been shown that with the stimulus paper in front of the subject while he is copying the dot, there still occurred a mean deviation of 12·70 mm. from the true location. Accordingly, when Fig. 1—the Forgetting Curve—was constructed, the

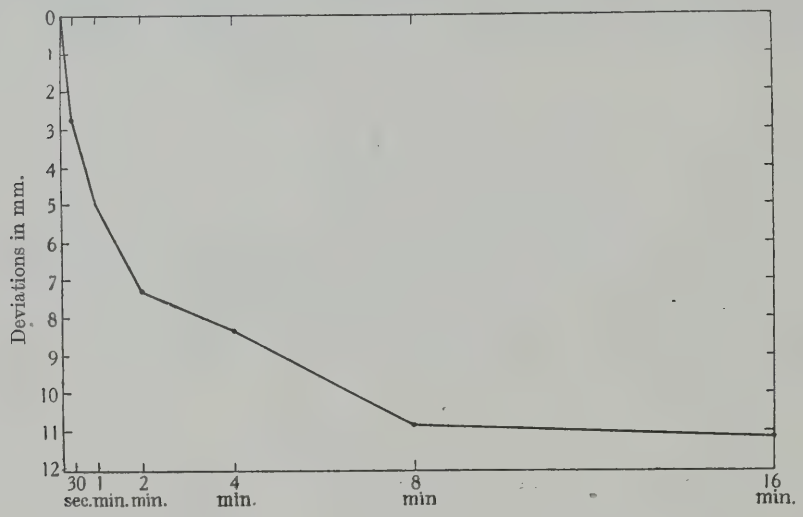

Fig. 1. Forgetting curve.

curve was corrected for this error in copying. From the mean deviation score for each time interval was subtracted the mean deviation which took place during copying (12·70 mm.). The resulting curve took on the "main characteristics (of) a rapid fall immediately after learning and a gradual flattening out as the interval is prolonged. Forgetting becomes more and more gradual as time advances" ((3), p. 54).

An effort was made to determine the relationship between the size of copy error and that of memory error after each of the intervals. This was done by means of product moment correlations and the results appear in Table 3. It will be noted that no relationship existed

Table 3. *Relationship between copy and memory errors*

Copy and 30 sec. interval	$r = -0{\cdot}07 \pm 0{\cdot}09$
„ 1 min. „	$r = -0{\cdot}09 \pm 0{\cdot}09$
„ 2 min. „	$r = 0{\cdot}06 \pm 0{\cdot}09$
„ 4 min. „	$r = -0{\cdot}02 \pm 0{\cdot}09$
„ 8 min. „	$r = 0{\cdot}01 \pm 0{\cdot}09$
„ 16 min. „	$r = 0{\cdot}09 \pm 0{\cdot}09$

between those who made the greatest errors in copying and those who reproduced the position of the dot most poorly. Stated in another way, it may be said that no relationship existed between ability to copy a dot in its exact location and ability to remember the location of a dot after various time intervals.

(3) *The memograph results*

As stated in the beginning, this writer has constructed a series of memographs to indicate the distance and direction which the deviations took after each time interval for each subject. By means of these memographs, it is possible to determine just where and how far the memory trace for the position of the dot has changed. In order to make them easier to follow, these markings were employed: The true location of the dot as found on the stimulus paper is marked by a small blank circle and indicates the start of the path taken. Every fifth deviation is numbered and the location of every twentieth deviation is marked by a black circle. The small square shows the final point reached; i.e. by the sixtieth subject. It must be borne in mind that these deviations represent a combination of true forgetting and copy error, and in a discussion of the results allowance must be made for this fact. For this reason only generalizations concerning the memographs can be made, for, since no relationship was found between copy errors and memory errors, it is impossible to correct for the individual subject on the memograph.[1]

(*a*) *The* 30 *sec. serial memograph.* Most of the deviations occurred in a south-easterly direction, and within a relatively small radius, from the original starting point. The memograph ended to the left and close to the small blank circle.

(*b*) *The* 1 *min. serial memograph.* The path of deviations rose upward, then a bit to the right, down to the lower right-hand part of the paper, over to the left and back to a point a little to the left and 15 mm. from the starting point.

(*c*) *The* 2 *min. serial memograph.* The deviations started upward, swung slightly to the right, then back under the starting point, up toward the upper left corner and down to the lower left part of the paper.

(*d*) *The* 4 *min. serial memograph.* At first the deviations hovered around the starting point, then swung to the upper central part of the paper, then down under the starting point, and finally up the left side of the paper.

(*e*) *The* 8 *min. serial memograph.* The path of the deviations went upward and slightly to the left for about twenty-five memory traces, then down to the left middle section of the paper to near the bottom edge and upward again. At least 95 % of the traces took place left of the starting point.

(*f*) *The* 16 *min. serial memograph.* The memory traces started downward, then travelled vertically up along the middle of the paper to near the top and upper left, down along the middle and over toward the lower left part of the paper. Over 80 % occurred to the left of the starting point.

(*g*) *General summary of memograph results.* (1) All memographs ended to the left of the starting point. Whether this is due to chance, to the nature of the group, to the path of earlier traces, or is a true tendency remains for future investigation.

(2) How far away the memograph ends from the starting point after sixty memory traces does not appear to be related to length of time interval.

[1] It was impossible to reproduce all the memographs, for reasons of space. The 16 min. memograph is shown in Fig. 2, as a representative specimen.—Editor, *B.J.P.*

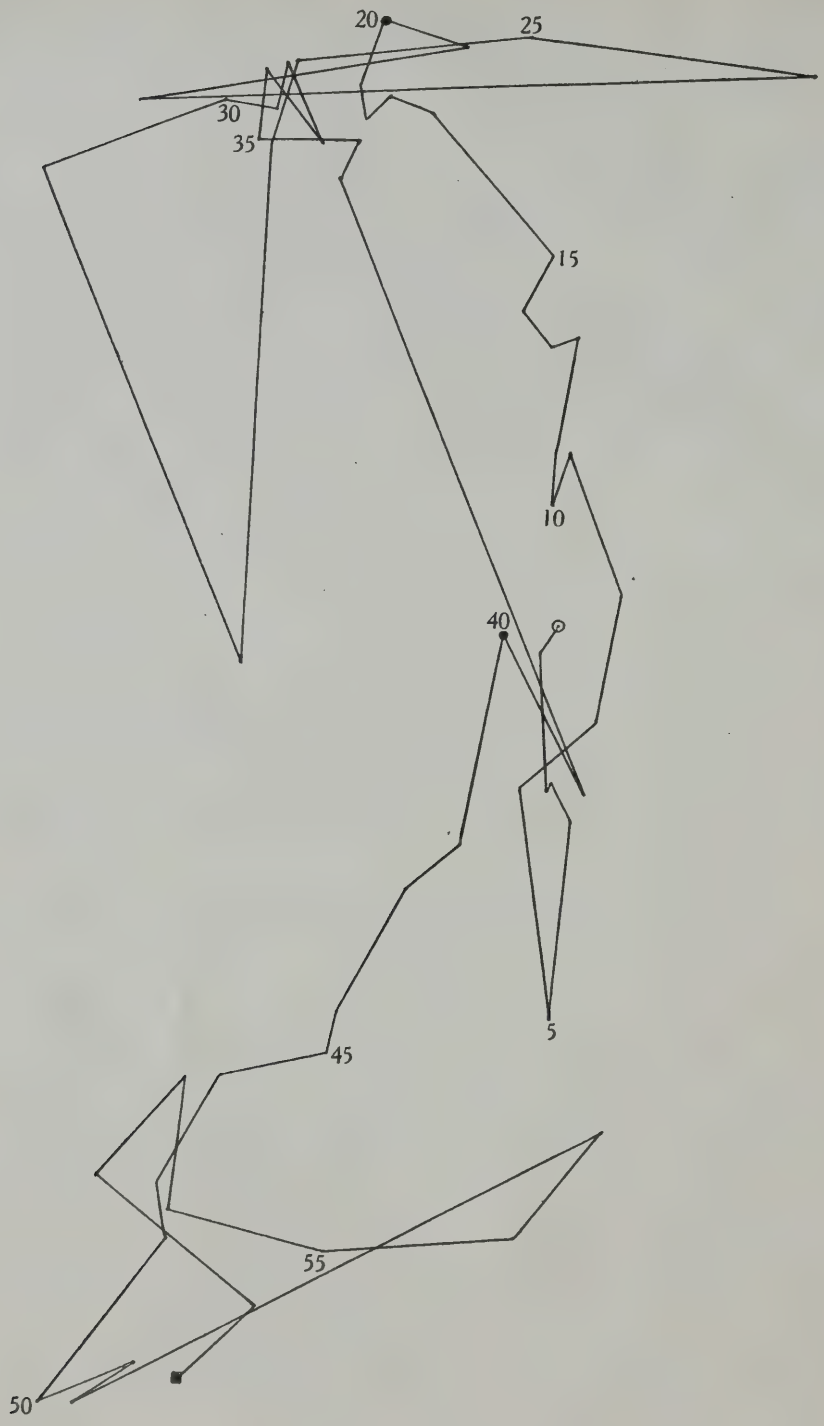

Fig. 2. 16 min. serial memograph.

(3) No general pattern, configuration, or constellation was apparent in the paths which the memory traces followed. In the first two memographs, most of the traces seemed to be over to the right. In the later ones, they seemed to go over to the left side of the paper. Whether this is a real phenomenon or simply an artefact remains for further study.

(4) *Reliability of the differences between the subgroups*

Table 4 indicates that after no time interval and between no subgroups was a statistically reliable difference found. In other words, for memory of position there was no significant difference found between boys and girls, white and coloured, low and high I.Q. groups, and older and younger after any of the filled time intervals.

Table 4. *Reliability of the differences between the subgroups*

		30 sec.			1 min.			2 min.		
		Mean	S.D.	C.R.	Mean	S.D.	C.R.	Mean	S.D.	C.R.
Sex:	Male	16·20	9·42	0·66	18·00	21·60	0·11	21·60	19·84	0·72
	Female	14·60	9·53		18·52	17·16		18·54	12·12	
Race:	White	14·40	9·68	0·70	19·87	19·81	0·55	17·07	9·67	1·39
	Negro	16·10	9·22		17·00	20·40		22·93	21·01	
I.Q.:	Low	15·20	9·26	0·19	22·67	26·50	1·84	20·80	19·82	0·40
	High	15·40	9·45		13·40	7·41		19·07	12·68	
Age:	Older	14·13	8·98	1·06	17·67	20·65	0·25	19·73	20·18	0·06
	Younger	16·71	9·79		19·00	19·78		20·00	12·38	
		4 min.			8 min.			16 min.		
Sex:	Male	23·00	18·12	1·12	28·00	24·34	1·70	21·47	14·11	0·89
	Female	18·40	13·12		19·20	14·71		26·40	26·80	
Race:	White	20·20	17·83	0·49	24·26	24·16	0·14	21·00	21·12	0·98
	Negro	22·27	14·64		23·53	16·24		26·40	21·41	
I.Q.:	Low	23·73	19·24	1·36	24·27	20·83	0·20	26·93	22·32	1·18
	High	17·07	12·21		23·20	21·12		20·40	20·58	
Age:	Older	23·07	15·91	1·02	24·13	21·14	0·08	23·20	17·54	0·19
	Younger	19·20	15·49		23·73	20·83		24·27	25·12	

IV. SUMMARY AND CONCLUSIONS

Sixty children of the Sixth Grade with a mean age of 142·8 months were requested to copy a 1 mm. dot placed equidistant from the top and sides of a 28 × 21·6 cm. paper on to another paper of the same size in exactly the same spot. The group had an equal number of boys and girls and of white and coloured children. The mean I.Q. of the group was 95·8 points. Then the children were required to copy dots from memory, after various filled time intervals, by Bartlett's serial reproduction method.

The results are presented by means of tables of reliable differences and correlation, a forgetting curve (corrected for copy error), and a series of memographs—a simple but effective way of graphically indicating to the reader the direction and distance of the subjects' memory traces for each time interval. The results show:

(1) When copying a dot, the subjects deviated from the true position by a mean of 12·70 mm.

(2) In copying the position of a dot, no significant differences were found between the boys and girls; the white and coloured children; the older and younger subjects; and those of higher and lower mental ability (as measured by I.Q.).

(3) Reliable differences between copy errors and memory errors occurred only after the 2 min. and greater intervals.

(4) When corrected for copy error, the resultant curve tended to possess the chief characteristics of the typical forgetting curve.

(5) No relationship existed between ability to copy a dot in its exact position and ability to remember the location of a dot after a variety of filled time intervals.

(6) Memograph results were presented in descriptive and general terms. Some observations which were noted were:

(*a*) All memographs ended to the left of the starting point.

(*b*) The distance between the starting and ending points (when 60 subjects participated) bore no relation to length of time interval.

(*c*) No definite pattern could be discerned from the paths taken by the memory traces.

(7) As in copying, no reliable differences were found to exist between the sexes, the two races, the older and younger, and higher and lower I.Q. groups for memory of the position of a dot after various filled time intervals.

REFERENCES

(1) BARTLETT, F. C. (1932). *Remembering: A Study in Experimental and Social Psychology.* Cambridge University Press.

(2) HANAWALT, N. G. (1937). "Memory trace for figures in recall and recognition." *Arch. Psychol., N.Y.*, no. 216.

(3) WOODWORTH, R. S. (1938). *Experimental Psychology.* Pp. 860. New York: Henry Holt.

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PROCEEDINGS OF THE BRITISH PSYCHOLOGICAL SOCIETY, 1943

GENERAL MEETINGS

March 20, 1943. GENERAL MEETING IN LONDON (arranged by the Medical and Education Sections).
"The Methods of Training Child Psycho-Therapists at the Institute of Child Psychology." By MARGARET LOWENFELD.
Discussion opened by:
KATHLEEN TODD (representing the London Child Guidance Training Unit).
SYLVIA PAYNE (representing the British Psycho-Analytical Society).
Representatives of the Tavistock Clinic also took part in the discussion.

April 8–12, 1943. ANNUAL GENERAL MEETING AT OXFORD.

April 8. **1st Session.** Business, followed by Presidential Address:
"British Psychology in War-time." By C. BURT.

April 9. **2nd Session:**
"The Psychology of Modern Germany." By WILLIAM BROWN.
"The Psychological Problem—Germany." By P. SENFT.
"The Child-Adult Relationship." By C. A. CLAREMONT.

3rd Session:
"Adolescent Leisure." By H. E. O. JAMES.
"Loneliness in Young Children." By THEODORA ALCOCK.
"Boredom." By HILDE LEWINSKY.

4th Session:
"Some Problems of Youth Training." By C. W. VALENTINE.
"Form and Colour." By OLIVE E. PEAKE.
"An Experimental Analysis of Suggestibility." By H. J. EYSENCK.

April 10. **5th Session:**
Symposium: "Mental Attitudes in Time of War."
"Hatred of the Enemy." By R. H. THOULESS.
"Psychological Implications of 'Re-educating the Germans.'" By T. H. PEAR.
"What are we to think?" By RANYARD WEST.
"Theoretical Aspects of *Psi* Phenomena." By R. H. THOULESS and B. P. WIESNER.

6th Session:
(*a*) "Languages and Wars."
(*a*) "Religions and Wars." } By L. F. RICHARDSON.
"Isomorphism." By R. W. KOSTERLITZ.

7th Session:
"Post-War Planning for Psychology." By C. S. MYERS.

8th Session:
"Psychological Aspects of Vitamin B Deficiency." By J. LEYCESTER KING, S.J.
"Assessing Intellectual Impairment in cases of Brain Lesion." By O. L. ZANGWILL.

April 11. **9th Session:**
"Primitive Kinship as Mirrored in Modern Man." By JOHN LAYARD.

10th Session:
"Comparative and Critical Aesthetic Judgment." By JAMES MAINWARING.

11th Session:
Open Session for Discussion.

September 4, 1943. GENERAL MEETING IN LONDON.
Discussion on:
"The Problem of Representative Sampling of the Population."
"Population Sampling." By LOUIS MOSS.
"Some Sampling Problems in Housing and Planning Surveys." By DENNIS CHAPMAN.
"Inquiries into Nutrition and Food Habits." By GERTRUDE WAGNER.
"Classification and Sampling Technique." By KATHLEEN BOX.
"Value of Sampling Methods in Government Research." By STEPHEN J. L. TAYLOR.
"The Need for Improved Social Statistics." By HENRY DURANT.

September 25, 1943. GENERAL MEETING IN LONDON (arranged in co-operation with the Mental Health Committee of the Provisional National Council for Mental Health).
Discussion on:
"Education of the Adolescent with special reference to the School-Leaving Age."
Papers by: ALAN MABERLY, OLIVE WHEELER, F. A. JENKS, and J. C. HILL.

SECTIONAL MEETINGS

MEDICAL SECTION

March 20, 1943. (See GENERAL MEETINGS, above.)

EDUCATION SECTION

March 20, 1943. (See GENERAL MEETINGS, above.)

INDUSTRIAL SECTION

October 7, 1943. "Methods of Payment: Some Psychological Considerations." By NORAH M DAVIS.

SOCIAL PSYCHOLOGY SECTION

July 23–24, 1943. TWO-DAY MEETING IN LONDON.

July 23. Business, followed by Papers:
"An Experimental Investigation of Stereotypes." By MADELINE KERR.
"Stereotypes: Their Nature and Significance." By C. A. MACE.

July 24. "The Psychological Background of White-Colour Contacts in Britain." By K. L. LITTLE.
"The Nature of Anti-Semitism." By M. GINSBERG.

BRANCH MEETINGS

SCOTTISH BRANCH

February 6, 1943. "Monoglot and Bilingual Children in the Hebrides and Shetland Islands." By J. R. MORRISON.
"On Narcissism." By K. M. ABENHEIMER.

March 6, 1943. "Problems of the Outpatient's Psychiatric Clinic." By ANGUS MACNIVEN.
"Educational Guidance." By F. M. EARLE.

November 6, 1943. "On Identifying Aesthetic Types." By EDWIN A. PEEL.
"The Present Aversion from Teaching: Its Causes and Consequences." By REX KNIGHT.

December 5, 1943. "Barns Hostel for Difficult Evacuees." By W. DAVID WILLS.
"An Experimental Painting Class in the Army." By R. WELLS.

MIDLAND BRANCH

No meetings of the Midland Branch were held in 1943, but it has resumed meetings in 1944.

NORTHERN BRANCH

The Northern Branch has been unable to arrange meetings since the outbreak of war, and th Secretary is now on Active Service in India. It is, however, planned to resume meetings in 1944.